

similar to that in Figure 3. The number of stimuli required to close the trap is plotted against the interval between stimuli. The data from Figure 3 could be plotted on the graph at (1, 6). They are somewhat above the average number of stimuli observed by Brown to be sufficient to close the trap at this interval. This is most likely due to the fact that Brown's traps did not have to lift the hinged device and stylus and thus less work was required to move the lobes enough to close them. The data in Figure 4 and Brown's other data indicate that behavior similar to that observed by Burdon-Sanderson at one and two minute intervals can be observed at stimulation intervals of up to 20 minutes.

Of course no insect is going to patiently sit and stimulate a trap at 20 minute intervals for the seven hours it would take to get caught. Only the first two touches are likely to be important in the initial capturing movements in nature, where it may be hypothesized that the lack of response to the first touch benefits the plant by preventing accidental closure by windblown sand, raindrops, etc. As it struggles inside, the insect delivers to the hair many closely spaced stimuli which aid in tightening the trap* but nowhere would one expect to see stimuli applied at intervals similar to those Brown used. What do such experiments demonstrate then? The response to stimuli delivered at long intervals gives us a much more accurate description of the trap movements and allows them to be compared to movements in other plants and animals. The data may help in elucidating the mechanism of trap closure. It should also be of interest to evolutionary botanists since a similar phenomenon exists in Drosera where more than two responses are normally involved in tentacle movement.**

* Burdon-Sanderson proved this by attaching weights to the stylus shown in Figure 1. This forced the lobes open but further stimulation closed them again, lifting the weights in the process.

** The movements of Drosera and their similarity to those of Dionaea are discussed in 1972 in my papers with Barbard Pickard, (Planta 103, 193).

SOME FIELD OBSERVATIONS OF DARLINGTONIA AND PINGUICULA

by Robert R. Ziemer

In mid-February I visited a number of field sites in the Smith River drainage of northwestern California near Gasquet where Darlingtonia (Chrysamphora) californica and Pinguicula vulgaris grow extensively. All of the sites I located were confined to areas underlain by Mesozoic ultrabasic intrusive rocks. I could find no CP sites on the metavolcanic rocks which surround the ultrabasics. Whether parent material is a limiting condition in this region would require a more detailed investigation.

The climate at Gasquet can be classed as Mediterranean--cool, wet winters with warm, dry summers. Rainfall averages 94 inches with less than 5% falling from June through September. Winter temperatures are mild with a mean minimum January temperature of 35° F. and the lowest observed temperature near 20° F. The maximum mean July temperature is about 75° F. with a maximum observed temperature near

103° F. The average length of the 32° F. growing season is 225 days, and of the 28° F. growing season is 300 days. The area accumulates 4,700 heating degree-day units (the accumulation of mean daily temperatures in degree units below 65° F.).

The habitat where these two species were found was rather diverse but a constant water supply with neither drought nor flooding seemed to be present in all cases. Several diverse but typical locations will be described to illustrate the range of habitat.

About a mile north of Gasquet there is a very small flat drainage which flows toward the south with a slope of about 25 percent. Extensive stands of Darlingtonia can be found in the minute creek in an area extending about 1/3 mile in length and 10 to 50 yards in width. Growing amongst the Darlingtonia are scattered Pinguicula. Other dominant interspersed vegetation are sugar pine, cedar, tan-oak, manzanita, azalea, rhododendron, and grasses. The subsoil is reddish and clayey with many rocks and cobbles. The Darlingtonia and Pinguicula roots seem to be confined to a thin surface layer of peaty or marly soil which is quite wet, but without extensive standing water evident. As the site becomes drier, first the Pinguicula disappear and then the Darlingtonia. The Darlingtonia are definitely confined to the moist zone, however. The topographic transition is very gradual, but the hydrologic and vegetative transition is abrupt. The surrounding hillslopes are quite dry at the surface. The surface moisture is supplied by a spring which has been tapped for domestic uses. The aquifer runs over a soil-rock interface about one foot under the surface and emerges in a shallow pit. Darlingtonia first appear where the water reaches the surface and continues downslope until the water enters an obvious topographic channel. The insolation received on this south facing slope is great--being in full sunlight perhaps 80% of the available sunlight hours.

The second site is about one mile further north on a north facing 80% slope which receives less than one hour of direct solar radiation during the winter and perhaps six hours during the summer. Here the Darlingtonia is found in pure stands which are confined to very narrow rivulets that appear dry--even in winter--until one digs a hole through the mat of Darlingtonia roots and dead pitcher leaves and finds free water. The Darlingtonia are confined to a bench about 100 yards wide between the steep fir-covered hillslope and the bare rock cliff of the river. The rivulets could be called a river of pure Darlingtonia, one to three yards wide extending about 500 yards. Nothing successfully competes with the Darlingtonia in these areas--it being a solid mat of plants with an abrupt transition to grass, herbs, and brush at the edges. Where the rivulets reach the edge of the rock cliff only a constant dripping of water is seen and Darlingtonia can be found wherever soil can accumulate among the rocks. Pinguicula can be found only on the rock face in wet, dripping crevices. Many areas where Pinguicula are found receive no direct sunlight during the year. Some are even found growing upside-down on overhanging rocks and must receive very little light. Pinguicula were also found growing in areas with no soil, such as between two tightly pressed cobbles. When the cobbles were removed and separated, no soil could be found. In winter bud, the plants cling so tenaciously

to the rocks that Pinguicula were found growing below the river's winter highwater mark where all other vegetation had been swept away. In summer growth, the leaves seem so delicate and easily damaged that it is difficult to imagine their ability to survive the torrential river flows of winter. Thus, in the first site Pinguicula were found growing among the Darlingtonia, in this site the Darlingtonia were in pure stands and the Pinguicula were confined to the rock face.

In another site Darlingtonia was found growing together with scattered Drosera rotundifolia in a true Sphagnum bog in standing water and very deep mud. (I know this from inadvertently sinking up to my thighs in the goo.) No Pinguicula were found in or near this bog. At this site I found several Darlingtonia growing on a spruce log spanning a portion of the bog. The plants were more scattered than at the previous two sites in that seedlings of spruce and cedar were found growing among the Darlingtonia. The plants could be uprooted with no broken roots simply by pulling on the pitchers, whereas in the previous two sites pulling on the pitchers resulted in broken plants.

A final site on Patrick Creek is interesting for its unique habitat. Behind an abandoned cabin a water diversion had been constructed to carry water from a small creek across a dry southeast facing hillside to some ponds. The hillside had a coarse gravel to cobble soil and a sparse cover of manzanita, ceanothus, and scattered Douglas-fir. A flourishing stand of 18-inch tall Darlingtonia was growing on the banks of the small water diversion channel which carries a flow of uniform depth all year. Thus, even in this severe site Darlingtonia can become established if provided a constant water supply.

In conclusion, in the Smith River drainage carnivorous plants were only found associated with ultrabasic intrusive rocks. Darlingtonia seemed to be limited to areas having a constant and uniform supply of cold water. They were absent from areas that showed either flooding or drought. Soil texture was variable, ranging from wet muck, through thin organic surface soil with a clayey subsoil, to gravel alluvium, to a diversion channel embankment. Aspect and light intensity ranged from full sunlight on a south exposure to a very shaded north exposure having only an hour or so of direct summer sunlight.

Pinguicula showed its best development in the fissures on steep north facing rocky bluffs having constantly dripping water. Here they could be found in pure dense stands wherever water was available and the roots could penetrate the rock. Only occasionally was Pinguicula found growing on the open ground with Darlingtonia as in the first site. Thus, in this region the habitat requirements of Pinguicula seemed to be more exacting than that of Darlingtonia.